METALCASTING

Project Fact Sheet

Computer Process Model for the Cupola Furnace

Benefits

- Could save of 91 billion Btu of coal per installation annually
- Could save 5.7 trillion Btu annually by 2010
- Permits optimization of the cupola operation for both cost and energy savings
- Provides greater control of everyday cupola operation without the need for trial and error
- More accurately assesses the cost benefit of major cupola modifications

Applications

The new computer process model offers significant operating and cost advantages to both large and small cupola foundries throughout the United States and the world. Marketing will target 70% to 80% of the cupola foundries and focus on cost advantages, energy savings, and lower greenhouse-gas discharges. Foundry-industry suppliers will also have the opportunity to provide technical support services.

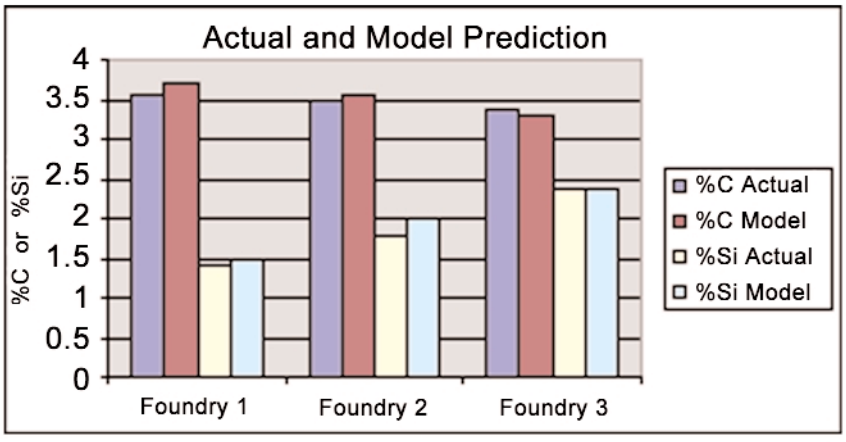
Breakthrough Computer Model Provides Extensive and Accurate Output Data on Cupola Furnace Processes

The cupola is the dominant scrap-melting furnace used in scrap-iron foundries, producing two-thirds of the liquid iron needed for castings. The cupola offers several competitive advantages relative to newer electric-melt furnaces, including lower energy and scrap costs, higher tolerance for harmful trace elements, and a wider allowable range of iron-production rates.

Despite these important advantages, the cupola also has several disadvantages, the most prominent one being process complexity. The cupola involves 40 or more chemical reactions and a range of physical processes, which leads to significant operating difficulties and inefficiencies, resulting in poor-quality iron, costly remediation, and scrapped metal and castings.

The new computer process technology is designed to integrate the many operational variables of cupola processes. The model is intended to better guide everyday cupola operations and cost-benefit decisions. By mastering and controlling the many variables involved, the computer process model can optimize operations and reduce energy consumption and greenhouse-gas emissions better than other available technologies.

Cupola Furnace Process Model Performance



The new computer process model for the cupola furnace, being developed by S. Katz Associates, Inc., allows an accurate description of the furnace during operation, resulting in reduced energy usage.

Project Description

Goal: Use cupola model revisions, experimental studies, and market development to deliver a unique computer program with greater capabilities, applications, and acceptance.

As a finite-difference, one-dimensional, steady-state program, the computer process model develops a proprietary set of material and heat balances in the form of differential and algebraic equations. The model considers many different variables, including gas-to-solid-to-liquid heat transfer; melting; heat loss through the shell, tuyeres, launders, slag, and offgas; carbon reaction with oxygen, water, and carbon dioxide; limestone calcination; oxidation of iron and alloys in the solid and liquid states; and carbon and ferroalloy dissolution in iron. The computer software also weighs the thermal effects of all the considered reactions, such as melting phenomena and dissolution of alloys and carbon.

The computer process model has been developed as a mathematical core, written in FORTRAN with a graphic-user-interface. The interface stores the input and output data and describes the cupola and charge materials on editable menus. The 22 files of output data are available in menu screens, plots, and tables.

S. Katz Associates, Inc., is developing this new technology with the help of a grant funded by the Inventions and Innovation Program in the U.S. Department of Energy's Office of Industrial Technologies.

Progress and Milestones

- Add radiant-heat transfer as a variable to improve prediction of iron temperature.
- Improve the model to consider effects of slag basicity and iron sulfur on alloy loss and carbon dissolution.
- Expand the database of cupola input/output data.
- Revise the algorithms describing silicon carbide performance.
- Update and improve the graphics interface to simplify operator use.

Economics and Commercial Potential

U.S.-based cupolas melted about 14 million metric tons of iron in 1999, and world production was at least four times greater. Although lightweight metals are replacing iron in some applications, slow growth is still projected for iron casting worldwide.

The U.S. market for the computer process model comprises about 140 foundries operating 250 cupola furnaces; about 1,300 cupola furnaces operate worldwide. At $8,000 per model, the U.S. market value is $2 million, with strong potential for additional sales to foreign-based cupola operators and to the industry's service companies.

This technology could save 91 billion Btu of energy per installation each year. First sales for the technology are expected by 2003. Improvements to the cupola are expected to take about two years after this new technology is acquired. Based on 25% market penetration by 2010, annual savings could be 5.7 trillion Btu with 62 cupolas having installed models. Market penetration of 90% by 2020 could save 17 trillion Btu from 187 operating units.

Industry of the Future—Metalcasting

The metalcasting industry – represented by the American Foundry Society (AFS), North American Die Casting Association (NADCA), and the Steel Founders' Society of America (SFSA) – has prepared a document, ***"Beyond 2000,"*** *to define the industry's vision for the year 2020. OIT's Metalcasting Vision Team partners with metalcasters, national laboratories, universities, and trade/environmental/technical organizations to develop and implement energy-efficiency technologies that benefit both the industry and the United States. Recently, the Metalcasting Team facilitated the development of the Metalcasting Technology Roadmap, which outlines industry's near-, mid-, and long-term R&D goals.*

OIT Metalcasting Industry Team Leader: Harvey Wong (202) 586-9235.

The Inventions and Innovation Program works with inventors of energy-related technologies to establish technical performance and conduct early development. Ideas that have significant energy savings impact and market potential are chosen for financial assistance througha competitive solicitation process. Technical guidance and commercialization support are also extended to successful applicants.

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